REMARKS/ARGUMENTS

Favorable reconsideration of the present application is respectfully requested.

Applicant has presented, in the Appendix hereto, proposed amended drawings, on which the legend "PRIOR ART" has been added to FIGS. 15A, 15B and 16. These proposed changes are believed to overcome the objection to the drawings set forth in the Official Action. Approval of the proposed changes and withdrawal of the objection to the drawings are respectfully requested.

Claim 1 has been rejected under 35 USC §112, second paragraph, as being indefinite. Specific objection was made to the use of the terms "small" and "large". Applicant has amended Claim 1 herein, and has modified the use of these terms to read "smaller" and "larger". The claim further identifies that the iron material, from which the output shaft is made, is the point of reference for the recited properties of the core metal portion of the worm wheel. These changes are believed to render the claim sufficiently definite to meet the requirements of the second paragraph of 35 USC §112, and withdrawal of the rejection of Claim 1 on this basis is respectfully requested.

Claims 1-3 have been initially rejected under 35 USC §103(a) as being obvious in view of a combination of the teachings of European Published Application No. 0 666 210, to Chikuma et al. and U.S. Patent No. 5,819,871, to Takaoka. Applicant believes that the amendments made herein to Claim 1 sufficiently clarify the scope of that claim such that it clearly patentably defines the invention over these references. Independent Claim 2 and Claim 3 depending therefrom are believed to patentably define, in their original form, the invention therein over the cited references. New Claims 4-6 have been added herein, and these claims also are

believed to be patentable over the cited references, for at least the reasons set forth herein.

Claim 1 recites an apparatus having a worm wheel, an output shaft, and a ring member serving as a torque limiter mounted between the worm wheel and the output shaft. The claim further sets forth that a gear portion of the worm wheel is to be made of synthetic resin, and that the core metal portion of the worm wheel is made of a metallic material having a specific gravity smaller than that of the iron material from which the output shaft is constructed, and having a coefficient of linear thermal expansion that is larger than that of the iron material.

As a result of a change in the spacing between the output shaft and the core metal portion of the worm wheel as a function of temperature, which is due to the difference in the coefficient of thermal expansion, the limit torque of the torque limiter will change. The limit torque will be at a higher value at low temperature, when the spacing D (see FIG. 4) is smaller, and will be at a lower value at higher temperatures, when the spacing D is larger.

The Official Action asserts that the Chikuma European patent document discloses an apparatus in which the core metal portion of the worm wheel is made of a metallic material whose specific gravity is small, and whose coefficient of linear expansion is large, relative to the material from which the output shaft is constructed. Such disclosure does not, however, appear to be present in the Chikuma reference.

Chikuma does not specifically disclose a material from which the output shaft therein would be constructed. Chikuma discloses a preference for the use of a structural steel, JIS S20C, for the core portion of the worm wheel. Without a disclosure of the material from which the output shaft is constructed, the reference cannot be said to disclose that a different material, namely one having a lower specific

gravity and/or a higher coefficient of linear thermal expansion, would or could be used for the core metal portion of the worm wheel. Further, the Chikuma patent appears to suggest that the material that is to be used for the output shaft and the core metal portion of the worm wheel should have substantially the same coefficient of linear thermal expansion.

The two passages that discuss the relationship of the output shaft to the worm wheel state that, "[A] worm wheel 111 is coaxially fixed to the output shaft 103..." (Column 3, lines 15-16)(emphasis added), and, "[T]he worm wheel 111 is connected to the output shaft 103 so that the worm wheel 111 and the output shaft 103 rotate integrally." (Column 4, lines 20-22) Were the core portion of the worm wheel to be made of a material having a coefficient of linear thermal expansion larger that that of the output shaft, this could well give rise to a situation, at elevated temperatures, in which the worm wheel would no longer be fixed to the output shaft, nor would it rotate integrally with the output shaft, due to a gap or partial gap forming between the two elements. Accordingly, the Chikuma reference does not disclose or suggest an apparatus of the type set forth in Claim 1, in which the core metal portion of the worm wheel has a higher coefficient of linear thermal expansion than does the output shaft.

This is the case, even though the Chikuma reference deals with effects of differences in coefficients of linear thermal expansion. Chikuma is focused on the differences in the coefficient of linear expansion between a resin portion of the worm wheel and the core portion of the worm wheel, and in factoring in this difference in designing an apparatus that will be capable of maintaining a suitable backlash between gears. The differences in this material parameter are taken into account in designing and sizing the components of the Chikuma apparatus. It is further evidence of the non-obviousness of the present invention that Chikuma was dealing with

problems related to the existence of differences in the coefficient of linear expansion between materials used in the apparatus therein, yet Chikuma completely failed to recognize or appreciate that certain advantages could be obtained by selecting the core metal portion of the worm wheel to have a different coefficient of linear expansion than does the output shaft.

The Official Action also recognizes that the Chikuma apparatus fails to disclose or suggest the use of a torque limiter in its electric power steering device. As noted above, Chikuma calls for the worm wheel and the output shaft to be rotated integrally. The Official Action asserts that it would have been obvious to incorporate a torque limiter in the form of a ring member into the Chikuma device, in view of the teachings of the Takaoka patent. It is stated that this would have been obvious because it would be recognized that this would result in increased wear life of the worm gear arrangement, thus reducing maintenance costs.

The Takaoka patent does not appear to address whether the use of a ring member as a torque limiter will increase the wear life or reduce maintenance costs for the apparatus. Instead, the particular torque limiter described in Takaoka is stated to be provided for maintaining a proper feeling in the steering operation. As such, neither of the cited patents contains any disclosure of the motivation that is alleged to make it obvious to a person of ordinary skill in the art to combine the references. The combination is thus not proper.

Even if the combination were proper, the combined teachings still do not disclose or suggest the invention set forth in Claim 1. As noted previously, the Chikuma reference does not contain any disclosure or suggestion to construct the core metal portion of the worm wheel from a material having a lower specific gravity and a higher coefficient of linear thermal expansion than that of the output shaft. In the

present specification, it is disclosed that the use of the materials having the different coefficients of expansion, coupled with the use of a torque limiter in the form of a ring member disposed between the worm wheel and the output shaft, provides the apparatus with a limit torque which varies as the operating temperature varies. Neither of the cited references discloses or suggests the desirability of incorporating such a feature in an electrically power assisting steering apparatus.

The Official Action further asserts that it would have been obvious to modify the apparatus of Chikuma such that the output shaft is made of iron material, and such that the core metal portion of the worm wheel is made of an aluminum or copper alloy, would have been obvious, on the basis that a person of ordinary skill in the art would have found it obvious to select a known material on the basis of its suitability for the intended use. A citation to Column 5, lines 24-26 is also made. The grounds for rejection do not contain any evidence that persons of ordinary skill in the art would recognize these materials as being suitable for the intended use, and, in particular, the suitability of the use of the two different materials for use in the same apparatus.

As already discussed, the Chikuma reference discloses a design in which the output shaft and the worm wheel are to rotate integrally. If persons skilled in the art were to somehow come to consider the use of an iron material for the output shaft, and the use of a copper or aluminum alloy for the core metal portion of the worm wheel, such a combination would not be likely at all to be found to be suitable, in that the coefficients of linear thermal expansion are sufficiently different that there would be a danger that the worm wheel would cease to rotate integrally with the output shaft. This consideration would indeed lead persons skilled in the art away from making

these material choices, which is further strong evidence of the non-obviousness of the invention set forth in Claim 1.

Accordingly, the invention of Claim 1 is not rendered obvious by the Chikuma and Takaoka references, either alone or in combination. Reconsideration and withdrawal of the rejection of Claim 1 under 35 USC §103(a) on this basis is therefore respectfully requested.

Turning now to new Claims 4-6, these claims are believed to be patentable over the cited references for much the same reason as is Claim 1. Claim 4 does not specify that the output shaft is made of iron material, but the claim does retain the feature that the metallic material from which the core metal portion of the worm wheel is constructed is to have a lower specific gravity and a higher coefficient of linear thermal expansion than the metallic material from which the output shaft is constructed. Claim 5 specifies that the core metal portion is to be made from either an aluminum alloy or a copper alloy. Claim 6 then specifies that the output shaft is to be made from iron material.

Independent Claim 2 is directed to an electrically power assisting steering apparatus in which the worm wheel is formed by joining a thin synthetic resin to an outer peripheral surface of the teeth portion of a gear-shaped core metal portion by chemical bonding of a composite molding technique, or by adhesive. Claim 3, which depends from Claim 2, further recites that the core metal will be either a copper alloy or an aluminum alloy. Neither the Chikuma reference nor the Takaoka patent appears to disclose such a construction for a worm wheel, and the Official Action does not make any such contention, either. Accordingly, no *prima facie* case of obviousness has been established relative to Claims 2 and 3.

As discussed in detail in the specification, at pages 4-8, 9-10, and in several passages in the section titled "Embodiments of the Invention", the use of a chemical bonding of the synthetic resin to the core metal portion provides several significant advantages over the known, principally mechanical or physical bonding approaches previously employed. The cited references do not appear to address this aspect of the invention. Accordingly, reconsideration and withdrawal of the rejection of Claims 2 and 3 is respectfully requested.

Applicant believes that all claims as now presented are in condition for allowance, and that all objections and rejections have been addressed and overcome. Passage of the application to issue at an early date is earnestly solicited.

Authorization is hereby given to charge any fee that is deemed to be owed as a result of the filing of this Amendment, to Deposit Account No. 501165. A duplicate copy of this paper is enclosed for deposit account charging purposes.

Respectfully,

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